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Conventional Combustion Environmental Assessment Program

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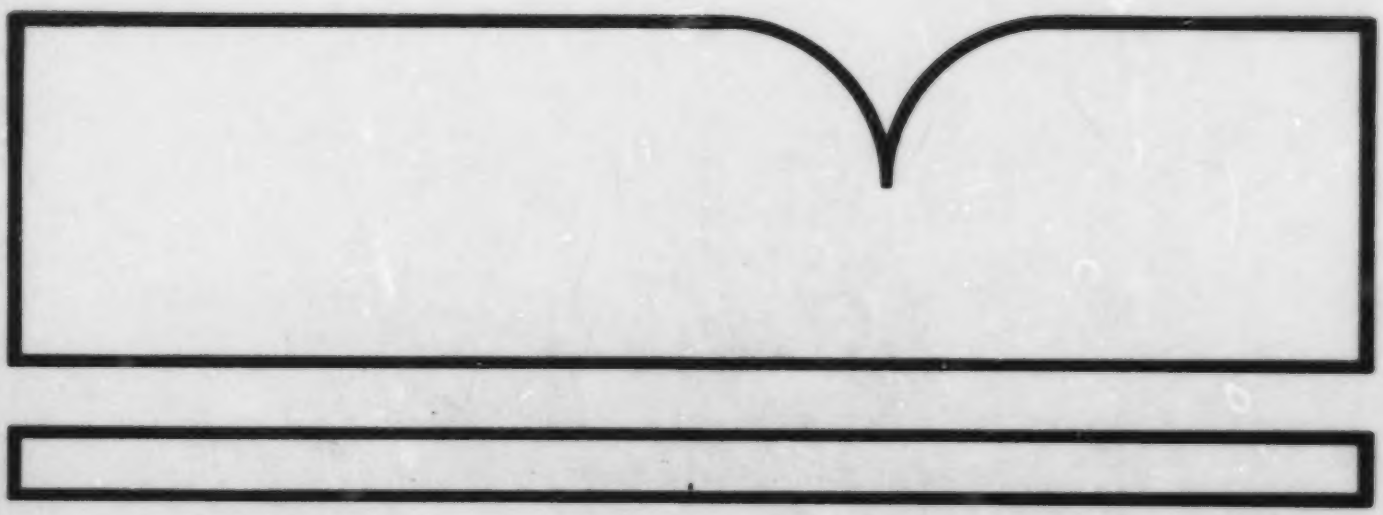

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16. ABSTRACT The report describes the development and initial results of EPA's Conventional Combustion Pollutant Assessment (CCEA) program planning effort, a recently established EPA program to consolidate the several segments of its research on the environmental effects of pollutants from conventional combustion processes into a comprehensive integrated effort. (In the past, much of EPA's environmental effects research has been performed in conjunction with control technology development.) Fossil fuels are now the Nation's principal source of energy for industrial, commercial, and residential use. The conventional combustion of fossil fuels and their derivatives is likely to remain our primary means of obtaining useful energy for several decades. EPA has, since its inception, conducted research on the environmental effects of fossil fuel combustion. The three principal purposes of such research are: (1) to assess the health and environmental effects caused by the release of combustion pollutants; (2) to define the need for technology to control the release of these pollutants; and (3) to develop standards to limit emissions.

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JOURNAL ARTICLE

CONVENTIONAL COMBUSTION ENVIRONMENTAL ASSESSMENT PROGRAM

Wade H. Ponder
Deepak C. Kenkeremath

Fossil fuels are now the nation's principal source of energy for industrial, commercial and residential use. The conventional combustion of fossil fuels and their derivatives is likely to remain our primary means of obtaining useful energy for several decades. EPA has, since its inception, conducted research on the environmental effects of fossil fuel combustion. The three principal purposes of such research are (1) to assess the health and environmental effects caused by the release of combustion pollutants, (2) to define the need for technology to control the release of these pollutants, and (3) to develop standards to limit emissions.

In the past, much of EPA's environmental effects research has been performed in conjunction with control technology development. Recently, EPA has established a program to consolidate the several segments of its research on the environmental effects of pollutants from conventional combustion processes into a comprehensive, integrated effort. This report describes the development and initial results of the Conventional Combustion Pollutant Assessment (CCEA) program planning effort.

I. INTRODUCTION

A. Background

The United States is one of the largest users of energy in the world. In 1976 more than 74.3×10^{15} Btu (78.4×10^{18} joules) of energy were used in this country to heat and cool buildings, to operate transportation systems, and to power industry (1). By 1985, this figure is expected to increase by approximately 50% and by the year 2000, the United States is projected to more than double its current energy use (2).

Historically, fossil fuels have composed the largest segment of the nation's energy resources. In 1972, for example, fossil fuels supplied more than 95% of the total U.S. energy need; even with the anticipated growth in nuclear, solar, and geothermal energy sources, fossil fuels are still expected to supply approximately 70% of the demand by the turn of the century. These values illustrate the magnitude of this country's current and future reliance on fossil fuels to supply its vital energy needs.

Wade H. Ponder is at EPA, Research Triangle Park, North Carolina.
Deepak C. Kenkermath is at Mitre Corporation, McLean, Virginia.

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Conventional methods of converting fossil fuels to useful forms of energy, however, are not without associated environmental penalties. The conventional combustion of fossil fuels has impacts which affect the air, land and water (multimedia impacts). Most conventional combustion processes emit oxides of sulfur (SO_x), oxides of nitrogen (NO_x), oxides of carbon, particulate matter, and other potentially harmful pollutants to the air. The post-combustion solid residues of the fuel (e.g., ash material) pose solid waste disposal problems. Leaching of chemical compounds and heavy metals from the solid residues and chemical transformation of airborne pollutants into other pollutants may also result in adverse water-related health and ecological effects. To complicate matters, these effects are not separate and distinct; rather, they are all interrelated and involve delicate balances and trade-offs. Flue gas scrubbing to remove SO_x and particulate matter, for example, significantly increases the amount of solid wastes to be disposed of in an environmentally acceptable manner. In addition, there are many indirect impacts that must be considered to understand fully the total impact on the environment. For example, the disposal of fly ash from coal-fired power plants has a direct impact on the land quality of the disposal sites. Leaching of chemical compounds and heavy metals from the disposal site has an indirect impact on the quality of the ground and/or surface water. This in turn may have impacts

on the ecology of the area. Comprehensive identification and evaluation of these multimedia impacts are essential to the environmentally wise use and control of conventional fossil-fueled combustion processes.

Extensive research by Government agencies and private organizations to identify and evaluate the adverse environmental impacts of conventional combustion processes and to develop methods of controlling such impacts has been conducted. The DOE "Inventory of Federal Energy-Related Environment & Safety Research for FY 1976" (3) --a limited inventory--lists over 2500 R&D projects for that year alone by 14 different agencies. Over a third of the total funding reported in the Inventory went directly for fossil fuel-related efforts. In addition to the Government, other organizations such as the Electric Power Research Institute, the American Gas Association, and the American Petroleum Institute also support millions of dollars worth of research in this area.

The Environmental Protection Agency (EPA), as the Federal organization with primary responsibility for controlling adverse environmental effects of pollutant emissions, has been active since its inception in determining the identities and quantities of potential pollutants released to the environment when fossil fuels are burned. Information from EPA's R&D efforts is being used for three principal purposes: (1) to assess the health and environmental effects caused by the release of combustion pollutants to the environment; (2) to define the needs for technology to control the release of these pollutants; and (3) to develop standards to limit emissions.

B. Rationale for the Conventional Combustion Environmental Assessment CCEA Program

Much of EPA's earlier work on characterizing pollutants from conventional combustion processes and assessing their effects on the environment was performed as an adjunct to programs whose major purpose was the development of control technologies for specific pollutants such as NO_x, SO_2, or solid wastes from combustion. In addition, studies by EPA and other organizations have generally had relatively specific objectives such as identifying emissions from a particular process, evaluating the effects of a particular compound, or developing technology to control a single pollutant. To date, however, few, if any, efforts have approached the environmental issue in a comprehensive, holistic manner. While data generated by past work have been important to developing an information base for conventional combustion processes, no studies have adequately addressed the identification and evaluation of the relationships that exist between the various environmental impacts. Furthermore, due to the very specific nature of study objectives and due to the number of organizations involved in conducting such studies, coordination and information exchange between efforts has been relatively minimal. Even a cursory survey of past studies would reveal overlap and duplication of efforts in some areas and absence of significant effort in others.

As R&D work in this area proliferates, it becomes necessary to channel these efforts into a systematic, coordinated, environmental assessment structure. A major integrated program has been undertaken to tie together the separate data generated by past and ongoing work and to complete a comprehensive environmental assessment of conventional combustion processes.

The methodology for the integrated program (described below) has been carefully developed by a multidisciplinary group, to maximize the understanding and use of program outputs by those involved in the coordinated effort and by the R&D community.

C. The CCEA Program and Its Objectives

In response to the need for a comprehensive environmental assessment of conventional combustion systems, the Environmental Protection Agency's Industrial Environmental Research Laboratory at Research Triangle Park (EPA/IERL-RTP), North Carolina, has developed and implemented a unified Conventional Combustion Environmental Assessment (CCEA) program. CCEA is a major new program aimed at the comprehensive assessment of environmental, economic, and energy impacts of multimedia pollutant emissions from stationary industrial, utility, residential, and commercial conventional combustion processes. The primary objective of the CCEA program is to identify and evaluate information from all relevant sources in order to: determine the extent to which this information can be utilized to assess the total environmental, economic, and energy impacts of conventional combustion processes; identify and acquire additional information needed for such assessment; define the requirements for modifications or additional development of control technology, and define the requirements for

modified or new standards to regulate pollutant emissions.

The CCEA program has coordinated and integrated ongoing and future studies into a unified umbrella environmental assessment structure and served as a centralized base of information on the environmental impacts of conventional combustion processes. Coordination and information exchange between CCEA-related studies minimizes duplication of effort and maximizes the return from available resources.

With the increasing concern over the health and ecological effects of energy conversion, coupled with the national goal of increased coal utilization, information and data developed from such an integrated effort is providing valuable inputs to technological and managerial decision-makers responsible for the continued and expanded use of conventional combustion processes at reasonable environmental, economic, and energy costs.

EPA/IERL-RTP has developed a working definition of an environmental assessment that is becoming accepted by the research community. For EPA and its contractors, an environmental assessment of fossil-fueled processes is defined as "a continuing iterative study aimed at:

(1) determining comprehensive multimedia environmental loadings and environmental control costs, from the application of existing and best future definable sets of control/disposal options, to a particular set of sources, processes, or industries; and

(2) comparing the nature of these loadings with existing standards, estimated multimedia environmental goals, and bioassay specifications as a basis for prioritization of problems/control needs and for judgment of environmental effectiveness." (4)

An environmental assessment involves neither the development or promotion of the combustion process nor the development or promotion of technology to control emissions from the combustion process. It is a continuing procedure that is carried out simultaneously with technology development to identify and evaluate the full range of impacts (including cross-media impacts and trade-offs) of the combustion process and/or control technology on the environment. The findings of an environmental assessment are aimed at providing a base of sound information for use by energy/environmental decision makers for:

- Standards Setting.
- Control Technology Development.
- Policy Formulation.
- Resource Allocation.

Outputs from a comprehensive environmental assessment range from mere listings of pollutant emissions and descriptions of evaluation techniques to identification of quantified environmental impacts and specific recommendations for decision making.

B. Functional Activities

What, then, is the range of activities that must be undertaken in order to satisfy the objectives of a comprehensive environmental assessment? What are the input requirements for these activities, and what are the relationships between the activities? Where does one draw the boundaries for an environmental assessment?

EPA/IERL-RTP has been active for some time in answering the above questions and in developing a methodology to incorporate EA components into its major programs. The environmental assessment methodology employed in the CCEA program draws heavily on the philosophies of the existing EPA/IERL-RTP methodology but has been expanded and modified to be more responsive to the assessment of conventional combustion processes.

1. Generalized Environmental Assessment Methodology

In the most elementary of descriptions, an environmental assessment consists of three basic iterative steps. (See Figure 1.)

1. Characterization of the combustion process (including any associated pollution control devices) and its effluents.

2. Assessment of the health and ecological impacts of the combustion process and its effluents on the environment, including:

-Identification of environmental (health) and ecological) impacts.
-Development of environmental goals and objectives.
-Comparison of impacts with environmental goals and objectives.
-Assessment of the magnitude of pollution impacts.

3. Evaluation of alternative control strategies for use with the combustion process.

The first step in an environmental assessment is to characterize completely the combustion process interms of a "back box" to identify all the pollutants emitted from the process, the quantities emitted, and the nature of the emissions (e.g., media involved, load distribution over time, and physical/chemical characteristics of the pollutants).

Once complete information on the effluents from the combustion process has been obtained, the second step of the environmental assessment is to determine the impacts of the process and its effluents on the environment. This process involves four general activities: (1) identification of the health and ecological impacts, (2) development of environmental goals and objectives, (3) comparison of the impacts with the goals and objectives to determine whether the impacts are acceptable, and (4) assessment of the magnitude of the pollution impacts. If the results of activity three in this step indicate that the impacts of the combustion process and its effluents on human health and the ecology are acceptable according to current environmental goals and objectives, then no problem is foreseen and the environmental assessment process has been completed. If, however, the results indicate that the impacts of the combustion process of its effluents are not acceptable according to current environmental goals and objectives, then the magnitude of impacts must be assessed in activity four and ways to amiliorate these impacts must be identified.

The third step in an environmental assessment is to identify and evaluate alternative methods of reducing the deleterious environmental impacts and to select the optimum control strategy for use with the combustion process.

This procedure is repeated for the combination of the given combustion process and the control technology selected in step three, and for each combustion process considered by the environmental assessment.

Technical reports are developed at every stage in the application of the environmental assessment methodology. Where impacts of the combustion process or its effluents on human health or ecology are serious, or where optimum existing control technologies are inadequate, specific recommendations for the development of stricter environmental standards or for the development of additional control technologies are made for consideration by the appropriate decision makers.

2. Detailed Environmental Assessment Methodology

A detailed environmental assessment methodology consists of various functional categories of information which interact to provide the desired data, information, or results.

As stated above, the first step in a comprehensive environmental assessment is the characterization of the combustion process and its effluents. Such a characterization comprises five functional categories of information:

* Process Technology Characteristics
* Fuels Characterization
* Input/Output Characterization
* Development of Sampling and Analysis Techniques
* Field Tests and Surveys

Figure 2 shows the elements of each functional category and the relationship between the characterization of the combustion process effluents (step one) and identification of the health and ecological impacts (step two). Each functional category in step one is briefly described below.

The functional category of Process Technology Characteristics is intended to provide detailed technical and operational information on the conventional combustion process. Information on the state-of-the-art of the combustion process including development status and commercial availability is considered in this functional category. The information includes process economics, energy efficiency, and process reliability.

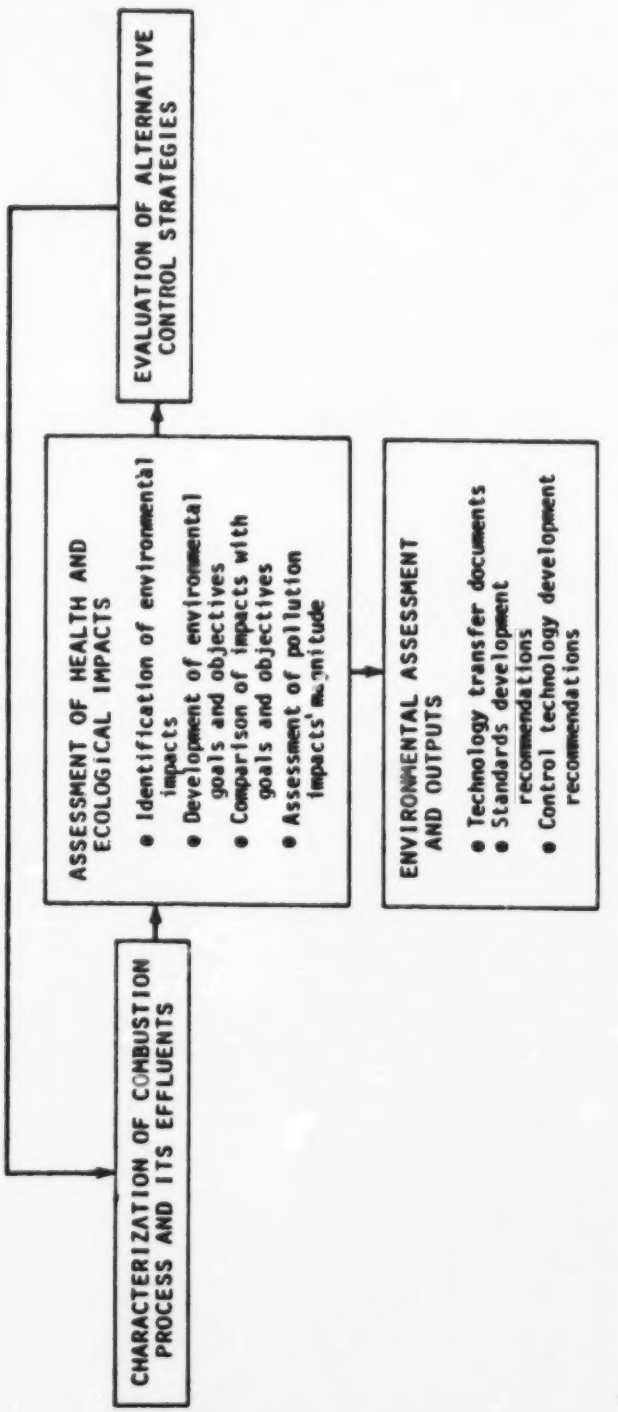
CHARACTERIZATION OF COMBUSTION PROCESS AND ITS EFFLUENTS
ASSESSMENT OF HEALTH AND ECOLOGICAL IMPACTS
• Identification of environmental impacts
• Development of environmental goals and objectives
• Comparison of impacts with goals and objectives
• Assessment of pollution impacts' magnitude
ENVIRONMENTAL ASSESSMENT AND OUTPUTS
• Technology transfer documents
• Standards development recommendations
• Control technology development recommendations
EVALUATION OF ALTERNATIVE CONTROL STRATEGIES

FIGURE 1
GENERALIZED ENVIRONMENTAL ASSESSMENT METHODOLOGY

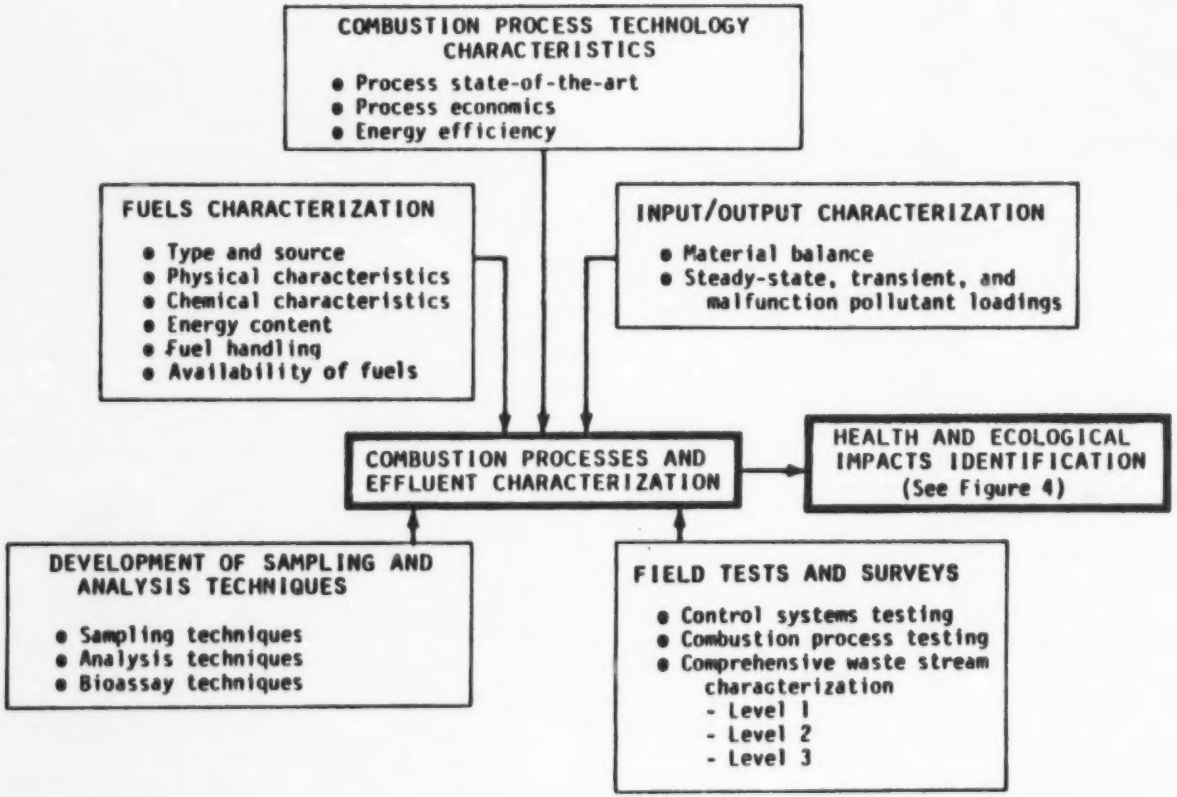

FIGURE 2
COMBUSTION PROCESSES AND EFFLUENT CHARACTERIZATION (STEP ONE)

The functional category of Fuels Characterization includes a description of the type and source of the fuel, physical and chemical characteristics including potential pollutants, energy content, fuel handling including methods of delivery and storage, and availability.

The functional category of Input/Ouput Characterization establishes the relationships among the process variables. Material balances for the combustion process and potential pollutant loadings for a variety of operating conditions such as steady-state, transient, and malfunction or other nonstandard states, are developed.

The functional category of Development of Sampling and Analysis Techniques (including bioassay techniques) is essential for assuring consistent and reliable results for comparison of data obtained by various investigators.

The functional category of Field Tests Surveys using the standard sampling and analysis techniques provides full quantification and characterization of the effluents. These tests and surveys are conducted on bench, pilot, demonstration, or full scale plants. EPA has established a phased screening, analysis, and monitoring protocol for various levels of waste stream characterization.(5) The three levels of characterization are:

Level 1 - Comprehensive Screening (including: "Criteria Pollutants").

Level 2 - Directed Detailed Analysis based on Level 1 findings.

Level 3 - Process Monitoring on Selected Priority Pollutants based on Level 1 and Level 2 findings.

The second step in an EA, the assessment of the health and ecological impacts of the combustion process and its effluents, is shown in Figure 3. The assessment of health and ecological impacts involves four general activities:

1) Identification of the health and ecological impacts of the combustion process and its effluents.

2) Development of environmental goals and objectives.

3) Comparison of the impacts with the environmental goals and objectives.

4) Magnitude of pollution impacts.

The identification of the health and ecological impacts of the combustion process (including any associated control technology) is the first activity of the second step. It includes detailed analysis of the response of the environment and the exposed population's health to the pollutant loadings of the process. This includes data collection and analysis relating to the air, water and land quality, ecology-related effects, increased morbidity and mortality rates, and quantified media degradation alternatives.

Combustion process and effluent characterization (the first step), previously discussed, serves as an input to health and ecological impacts identification as shown in Figure 4. Additional inputs to this activity are provided by the following functional categories:

- Ecological Impacts.
- Dose-Response Data.
- Pollutant Transport, Transformation, and Fate Models.
- Bioassay Data.
- Epidemiological Data.

Ecological Impacts identification is necessary to evaluate relevant information to quantify such concepts as media degradation.

Dose-Response Data allow the translation of pollution concentrations in the environment into an estimate of the number and type of specific biological impacts to be expected in an exposed population. Dose-response data relate exposure concentration and exposure time to the probability of observing a given biological response. Thus the exposure to a given SO_2 concentration for 3 hours may be expected to result in a certain number of cases of respiratory ailments, or a given average annual SO_2 concentration may result in an estimate of increased mortality. In addition to available dose-response data such as threshold limit values (TLV) and lethal concentration for 50% mortality in the exposed population (LC 50), information on occurrences of cancer, leukemia, respiratory disease, or other chronic or acute responses is often important in identifying the health and ecological impacts of the combustion process and its effluents.

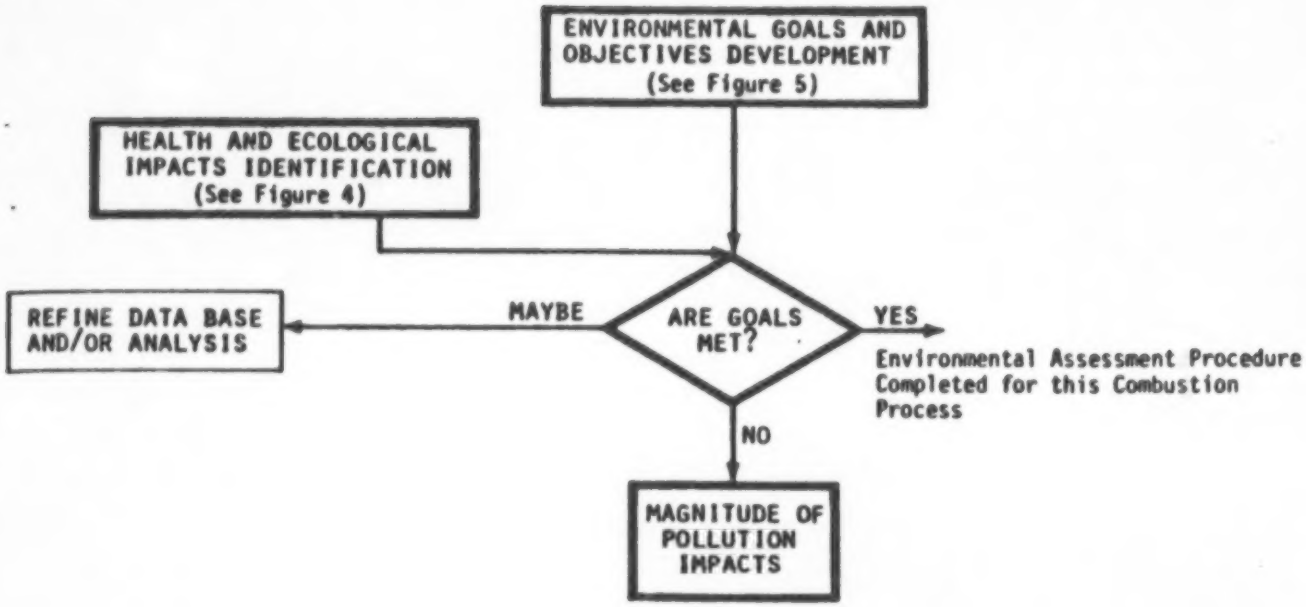
ENVIRONMENTAL GOALS AND OBJECTIVES DEVELOPMENT (See Figure 5)
HEALTH AND ECOLOGICAL IMPACTS IDENTIFICATION (See Figure 4)
REFINE DATA BASE AND/OR ANALYSIS
MAYBE
ARE GOALS MET?
YES
Environmental Assessment Procedure Completed for this Combustion Process
NO
MAGNITUDE OF POLLUTION IMPACTS

FIGURE 3
ASSESSMENT OF HEALTH AND ECOLOGICAL IMPACTS
(STEP TWO)

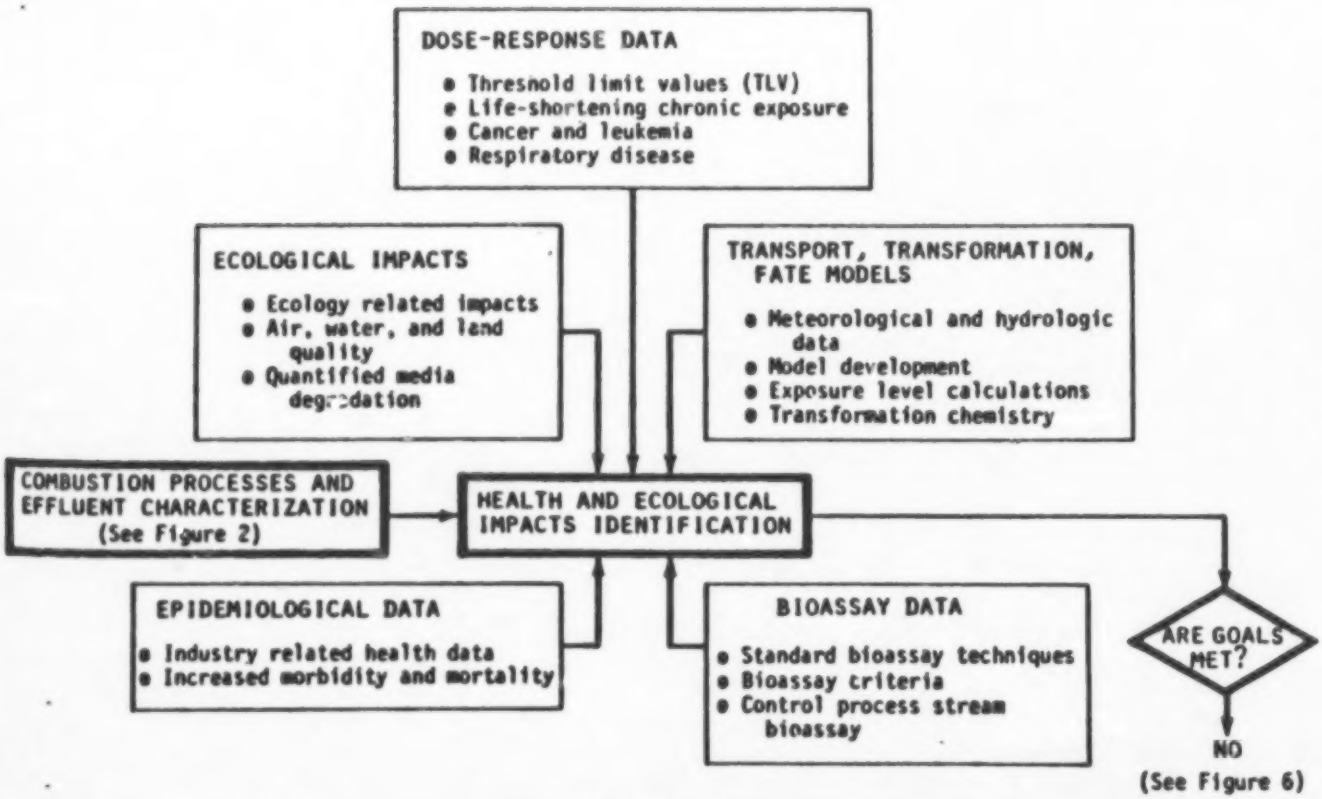

FIGURE 4
HEALTH AND ECOLOGICAL IMPACTS IDENTIFICATION
(FIRST ACTIVITY, STEP TWO)

Pollutant Transport, Transformation, and Fate Models are used in calculating pollutant concentrations and exposure levels. Meteorological data, hydrological data, chemical transformation data, and reactivity data must be developed for use in the models.

Bioassay Data identifying the effects of varying concentrations of pollutants on living organisms serve to augment dose-response data. Included among the bioassays of interest are those relating to health and ecological effects. Bioassays related to health effects include:

- Microbial bioassays (e.g., Salmonella typhimurium bacterial mutagenicity screening test).
- In vitro bioassays (e.g., alveolar macrophage cytotoxicity tests, epithelial cell carcinogenicity screen).
- In vivo bioasssays (e.g., mammalian toxicity tests, carcinogenicity screen).

Bioassays related to ecological effects include:

- Laboratory studies on single/multiple plant or animal species (e.g., acute toxicity studies, carcinogenicity screening tests).
- Microcosm studies of terrestrial, marine, or aquatic communities.
- Field studies of ecosystems.

Epidemiological Data developed from occupational exposure-related health information are important indicators of potential adverse pollutant impacts. Examination of vital statistics and data on specific illnesses and diseases in exposed populations may allow identification of the specific agent responsible or alert investigators to the possibility of such effects being associated with a particular process.

The second activity in the assessment of the health and ecological impacts (second step) is the development of environmental goals and objectives. These environmental goals and objectives are developed as standards or indices of acceptability. These indices of acceptability are based on a variety of interrelated factors including health effects, ecological effects, physical effects, socio-economics, and institutional/political and legals constraints. These environmental goals and objectives may be expressed in such terms as process/pollutant emission rates, ambient pollutant concentration in the various media, or environmental nondegradation criteria. As shown in Figure 5, the four major functional categories to be addressed in developing the environmental goals and objectives include:

- Statutory Constraints
- Emission or Ambient Level Goals
- Social/Economic/Political Institutional Considerations
- Ambient Pollutant Levels

Statutory Constraints considered in developoing environmental goals and objectives include:

- National Primary and Secondary Ambient Air Quality Standards
- State Implementation Codes
- OSHA Standards for Air Contaminants
- National Emission Standards for Hazardous Air Pollutants
- New Stationary Source Performance Standards
- National Interim Primary Drinking Water Regulations
- EPA Effluent Standards
- EPA Toxic Pollutant Effluent Standards (proposed)
- EPA Pesticide Limits
- Criteria for the Evaluation of Permit Applications for Ocean Dumping of Materials

Emission of Ambient Level Goals for each of the applicable air, water or land media may be based on control technology capabilities or on ambient factors. Goals based on control technology capabilities consider performance data on Best Available Technology (BAT), Best Practicable Technology (BPT), or engineering estimates for developing technologies to establish pollutant emission level indices. Goals based on ambient factors are dependent on the health or ecological effects of the pollutant. Factors considered in establishing ambient level goals include such parameters as Minimum Acute Toxicity Effluent (MATE) and health and ecological toxicity based on estimated permissible concentrations.

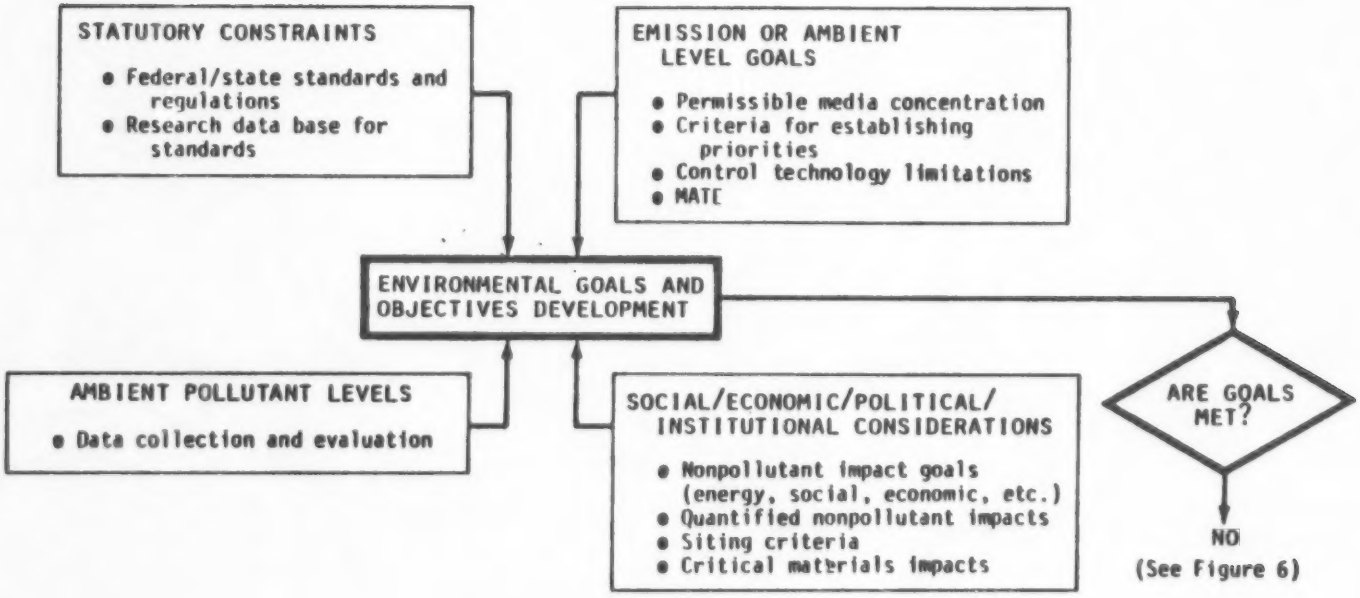

FIGURE 5
DEVELOPMENT OF ENVIRONMENTAL GOALS AND OBJECTIVES
(SECOND ACTIVITY, STEP TWO)

Social/Economic/Political/Institutional Considerations in developing environmental goals and objectives include a variety of quantitative and qualitataive factors such as the impact of the combusiton process on land use and degradation, water use, and other factors including energy use patterns, social/cultural patterns, regional and National economy, aesthetics, siting criteria, and critical materials impacts.

Ambient Pollutant Levels must be considered in setting such environmental goals as "no significant deterioration" (elimination of discharge based on not exceeding natural background levels). This can best be achieved through the extensive data collection and evaluation.

EPA/IERL-RTP has established a format for evaluating the information in each of the functional categories discussed above in order to develop measures of acceptability for each pollutant. These measures of acceptability, called Multimedia Environmental Goals (MEG's), are similar to the Emission or Ambient Level Goals described earlier but include consideration of the other three functional categories. An example of a MEG for the compound 2-aminonaphthalene is shown in Table 1. Table 2 shows a background information sheet summarizing all pertinent information used in developing the MEC for the compound. Currently, approximately 250 organic and 300 inorganic substances are on the MEG list.

The third activity in step two is the comparison of the health and ecological impacts identified earlier with the goals and objectives developed above. If all the health and ecological impacts are acceptable by current goals and objectives, then the EA process is finished. If there is any question about the acceptability of the impacts due to insufficient or unreliable data, a data refinement and re-evaluation interaction may be necessary to draw final conclusions. If, on the other hand, the impacts of the combustion process and its effluents are unacceptable according to current environmental goals and objectives, then the magnitude of these impacts must be assessed and methods to ameliorate or control them must be identified.

The assessment of magnitude of those pollution impacts not considered acceptable according to the goals and objectives is the fourth activity in step two (the assessment of health and ecological impacts). The major functional categories in this activity include:

- Combustion Process Use Projections
- Synergistic and Multimedia Impacts
- Total Pollutant Load Calculations
- Regional Geographic Data
- Pollutant Priority Ranking

These functional categories and their elements are shown in Figure 6.

Combustion Process Use Projections are used to determine the number and distribution of the combustion process in use both now and in the future (to the year 2000). Factors considered in this functional category include current and projected market size, and fuel supply/demand projections. Information developed in this functional category is used for total pollutant load calculations.

Synergistic and Multimedia Impacts are key considerations in comprehensive quantification of pollution impacts. For example, SO_2 emitted to the atmosphere may react with water to form acid and pollute surface and groundwater systems. Another multimedia effect is the leaching of heavy metals from solid waste disposal sites. Synergistic impacts such as the additive, transformation, or enhancement effects of two or more pollutants are also included in this functional category.

Total Pollutant Load Calculations are based on three types of information: (1) process loading, (2) loading from other sources, and (3) natural background loading. Total process loading is calculated in simple terms by multiplying the pollutant load from each combustion process by estimates of the number of such processes (determined in the process use projections functional category). Similarly, pollutant loadings from other conventional and nonconventional combustion sources must be determined to calculate the total pollutant loading from all combustion sources. In addition, natural background loading from non-manmade sources must be determined in calculating the total pollutant load to the environment.

Regional Geographic Data which are used to quantify environmental impacts, include regional population growth projections, and local hydrology and meteorology. These data, evaluated in terms of the regional total pollutant load and health effects data, should form the basis of environmental impacts quantification.

TABLE 1

SAMPLE MEG CHART[6]

MULTIMEDIA ENVIRONMENTAL GOALS

X
10C
2-AMINONAPHTHALENE

EMISSION LEVEL GOALS							
	I. Based on Best Technology		II. Based on Ambient Factors				
	A. Existing Standards	B. Developing Technology	A. Maximum Acute Toxicity Effects		B. Ambient Level Goal*		C. Elimination of Discharge
	NSPS, BPT, BAT	Engineering Estimates (R&D Goals)	Based on Health Effects	Based on Ecological Effects	Based on Health Effects	Based on Ecological Effects	Natural Background Level
Air, $\mu g/m^3$ (ppm Vol)			1.65E2		0.4		
Water, $\mu g/l$ (ppm Wt)			2.5E3	1.0E2	6	50	
Land, $\mu g/g$ (ppm Wt)			5.0E0	2.0E-1	0.012	0.1	

*To be multiplied by dilution factor

AMBIENT LEVEL GOALS					
	I. Current or Proposed Ambient Standards or Criteria		II. Toxicity Based Estimated Permissible Concentration		III. Zero Threshold Pollutants Estimated Permissible Concentration
	A. Based on Health Effects	B. Based on Ecological Effects	A. Based on Health Effects	B. Based on Ecological Effects	Based on Health Effects
Air, $\mu g/m^3$ (ppm Vol)			59		0.4
Water, $\mu g/l$ (ppm Wt)			291	50	6
Land, $\mu g/g$ (ppm Wt)			0.6	0.1	0.012

TABLE 2
SAMPLE MEG BACKGROUND INFORMATION SHEET[6]

CATEGORY 10C **MEG** 6662 02

2-AMINONAPHTHALENE $C_{10}H_9N$ (2-naphthylamine, β-naphthylamine).

STRUCTURE

White crystals that darken on exposure to light and air, volatile with steam.

PROPERTIES

Molecular wt 143.19, mp 113, bp 306, d 1.0614^{99}_{4}, vap. press. 1 mm at 130 °C, volatile in steam, slightly soluble in cold water.

NATURAL OCCURRENCE, CHARACTERISTICS, ASSOCIATED COMPOUNDS

2-Naphthylamine does not occur as such in nature, but is formed by the pyrolysis of nitrogen-containing organic matter. It has been isolated from coal-tar (ref. 44). It has, in general, the characteristics of primary aromatic amines. It is a weak base.

TOXIC PROPERTIES, HEALTH EFFECTS

Epidemiological studies have shown that occupational exposure to 2-aminonaphthalene is strongly associated with the occurrence of bladder cancer. There is no doubt that the compound is a human bladder carcinogen (ref. 44). 2-Aminonaphthalene is also reported to cause cancer in several animal species.

The EPA/NIOSH ordering number is 7628. The lowest dose to induce a carcinogenic response is reported as 10 mg/kg. The adjusted ordering number is 423.8.

LD_{50} (oral, rat): 727 mg/kg.

Aquatic toxicity: TLm 96: 10-1 ppm (ref. 2).

REGULATORY ACTIONS, STANDARDS, CRITERIA, RECOGNITION, CANDIDATE STATUS FOR SPECIFIC REGULATION

2-Aminonaphthalene is recognized by ACGIH as a carcinogenic agent in humans. No TLV has been assigned.

2-Naphthylamine was the subject of a NIOSH Hazard Review Document (ref. 43).

OSHA standards dealing with exposure of employees to 2-naphthylamine has been established taking into consideration substantial evidence that 2-naphthylamine is known to cause cancer (ref. 17).

MINIMUM ACUTE TOXICITY CONCENTRATIONS

Air, Health: $7 \times 10^4 / 423.8 = 165\ \mu g/m^3$

Water, Health: $15 \times 165 = 2.5 \times 10^3\ \mu g/l$

Land, Health: $0.002 \times 2.5 \times 10^3 = 5\ \mu g/g$

Air, Ecology

Water, Ecology: $100 \times 1 = 100\ \mu g/l$

Land, Ecology: $0.002 \times 100 = 0.2\ \mu g/g$

ESTIMATED PERMISSIBLE CONCENTRATIONS

$EPC_{AH2} = 0.107 \times 727 = 78\ \mu g/m^3$

$EPC_{AH3} = 0.081 \times 727 = 59\ \mu g/m^3$

$EPC_{WH1} = 15 \times 59 = 3,500\ \mu g/l$

$EPC_{WH2} = 0.4 \times 727 = 291\ \mu g/l$

$EPC_{LH} = 0.002 \times 291 = 0.6\ \mu g/g$

$EPC_{AE2} = 10^3/(6 \times 423.8) = 0.4\ \mu g/m^3$

$EPC_{WE} = 15 \times 0.4 = 6\ \mu g/l$

$EPC_{LE} = 0.002 \times 6 = 0.012\ \mu g/g$

$EPC_{WE1} = 50 \times 1 = 50\ \mu g/l$

$EPC_{LE} = 0.002 \times 50 = 0.1\ \mu g/g$

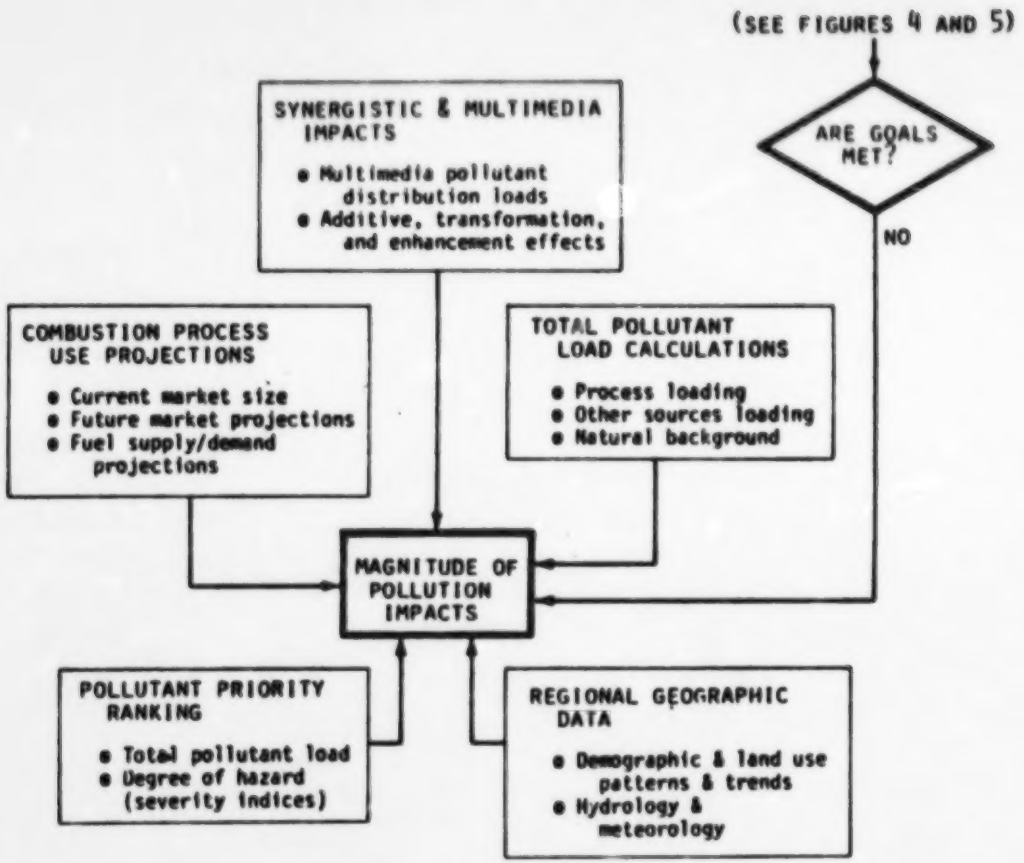
(SEE FIGURES 4 AND 5)
ARE GOALS MET?
NO
SYNERGISTIC & MULTIMEDIA IMPACTS
• Multimedia pollutant distribution loads
• Additive, transformation, and enhancement effects
COMBUSTION PROCESS USE PROJECTIONS
• Current market size
• Future market projections
• Fuel supply/demand projections
TOTAL POLLUTANT LOAD CALCULATIONS
• Process loading
• Other sources loading
• Natural background
MAGNITUDE OF POLLUTION IMPACTS
POLLUTANT PRIORITY RANKING
• Total pollutant load
• Degree of hazard (severity indices)
REGIONAL GEOGRAPHIC DATA
• Demographic & land use patterns & trends
• Hydrology & meteorology

FIGURE 6
MAGNITUDE OF POLLUTION IMPACTS
(FOURTH ACTIVITY, STEP TWO)

Pollutant Priority Ranking is then developed using the above data and potential degree or concern calculations (severity indices). This ranking is useful in identifying standards needs or pollution control needs.

Standards Development Recommendations result when impacts of the combustion process or its effluents on human health or ecology are serious and no Government standards exist to control these impacts. The identification of a need for modification or development of new standards is one of the major outputs of comprehensive environmental assessment. Recommendations for stricter (or more lax) standards should be ranked in order of priority and should be justified by specific data. Information on the degree of control desired would accompany such recommendations.

The third step in a comprehensive environmental assessment, Alternative Control Strategy Evaluation, is heavily dependent on the results of the first two steps. As shown in Figure 7, the identification, evaluation, and selection of the optimum alternative strategies or technologies to control unacceptable environmental impacts of the combustion process or its effluents include functional categories of information on:

- Control Alternatives
- Control Strategy Environmental Impacts
- Control Strategy Evaluation.

Control Alternatives addressing unacceptable pollutant impacts are identified based on existing technologies or on developmental technologies expected to become available in the near future. Alternatives considered include not only add-on control systems, but also such strategies as combustion modification or fuel switching/mixing. All reasonable alternatives are identified in this functional category for further evaluation and selection.

Control Strategy Environmental Impacts must be considered in order to assess any secondary environmental problems associated with the operation of the control system itself. This is necessary since many control systems emit substance(s) particular to their operation while others produce wastes (such as ash or sludge) as by-products of their operation. Options for the environmentally acceptable disposal of these wastes are also identified and evaluated in this category. Cross-media impacts are also important elements to consider in evaluating the environmental impacts of the control system. For example, while flue gas desulfurization (FGD) reduces gaseous pollutant emissions, it has a cross-media impact by increasing liquid and solid pollutants that require environmental control.

Control Strategy Evaluation is aimed at determining the optimum pollution control alternative for the particular pollutant, effluent/emission stream, or combustion process. This evaluation could be applied to both R&D-scale control technology or to demonstration-scale or fully commercialized systems. In addition to the pollutant removal efficiencies and operational availabilities of the systems, economics (including by-product disposal cost) must also be considered. Information on energy penalties imposed by the control strategy, the specific fuel mix availability, and industry acceptance of the strategy is also inlcuded in this functional category. In general, this evaluation is site-specific since ambient concentration levels and local meteorology and hydrology are important factors. EPA has developed a set of Source Analysis Models (SAM's) (5) to rank sources and effluents in priority order and to evaluate the environmental effectiveness of control alternatives. These sets of SAM's have been developed to date:

SAM/IA -- For Rapid Screening

SAM/I -- For Screening

SAM/II -- General Approach to Evaluating Any U.S. Regional Site

Control Technology Development Recommendations are logically made when existing or developmental alternatives for controlling adverse environmental impacts are inadequate. The recommendations for additional control technologies are among the most important outputs of an environmental assessment. These recommendations should be quantified and ranked in priority order for technological and managerial decision makers. The priority recommendations should be justified on engineering and environmental bases, and should include information on degrees of control required, additional R&D requirements, developmental cost estimates, and projected developmental schedules.

When optimum alternatives to contro unacceptable environmental impacts are selected, they are applied to the original combustion process and the entire environmental assessment procedure is repeated for the combination of the combustion process and the control

FIGURE 7
ALTERNATIVE CONTROL STRATEGY EVALUATION
(STEP THREE)

technology alternative. The complex, interactive and iterative nature of an environmental assessment is illustrated more clearly by combining each of the various steps and activities as shown in Figure 8. Ideally, the iterative methodology of Figure 8 is continued until all impact on human health and ecology caused by the combustion process falls within acceptable limits of current environmental goals and objectives.

III. CCEA PROGRAM PLANNING

The preceding section described in general terms the methodology for conducting a comprehensive environmental assessment of any set of combustion sources, processes, or industries. The CCEA program employs this methodology to conduct a comprehensive environmental assessment of stationary conventional combustion processes.

A. Overall Planning Techniques

As a part of the evolution of techniques for environmental R&D program planning, MITRE/Metrek (under contract to EPA) has developed a conceptual pattern characterizing the functional steps involved in such efforts. This conceptual pattern has been tailored to the specific CCEA program planning effort and is illustrated in Figures 9A and 9B.

This overall approach is divided into eight distinct tasks as indicated diagrammatically in Figures 9A and 9B and listed below:

1. Review of Existing EPA/IERL-RTP CCEA Projects.
2. Identification and Evaluation of Related Projects by other Organizations.
3. Disaggregation by Relevant Activities of Existing Projects into Environmental Assessment Functional Categories.
4. Structured Aggregation of Relevant Project Activities within Environmental Assessment Functional Categories.
5. Current Environmental Information Base.
6. Development of Goals and Objectives for Unified CCEA Program.
7. Evaluation of Integrated Existing CCEA Program.
8. Development of Unified CCEA Program Plan.

Task 1 involved the review of ongoing CCEA-related projects at EPA/IERL to identify their specific objectives, activities, milestones, and schedules. Simultaneously with Task 1, Task 2 identified, acquired, and reviewed information on past and ongoing combustion assessment-related projects outside of EPA/IERL-RTP to determine possible informational/program links with CCEA. Organizations surveyed within EPA included: Office of Environmental Engineering and Technology (OEET); IERL at Cincinnati; Office of Air Quality Planning and Standards (OAQPS); and EPA Regional Offices. Organizations surveyed outside of EPA included: Department of Energy (DOE) (Energy Research and Development Administration [ERDA]); Electric Power Research Institute (EPRI); Tennessee Valley Authority (TVA); Edison Electric Institute (EEI); Department of Commerce (DOC); Office of Science, Technology, and Policy (OSTP); Department of Agriculture (DOA); Department of Health, Education, and Welfare (HEW); and the National Science Foundation (NSF).

The information identified in Tasks 1 and 2 as being relevant to the unified CCEA was analyzed in Subtask 3, where specific activities of the relevant projects were disaggregated into generic environmental assessment functional categories. Activities addressing similar subjects or involving similar efforts in the various combustion assessment-related efforts were separated for comparative evaluation to be carried out in Task 4, where these activities were aggregated (or integrated) into a logical environmental assessment structure. By such structured integration, the basic characteristics of the unified CCEA would be delineated and the relationships between the activities of the various programs could be identified.

Concurrent with the integration of relevant projects into environmental assessment functional categories, two independent tasks were conducted to develop the goals and objectives of the expanded, unified CCEA. In Task 5, an information base of the current environmental background was established. The information base included data on existing and proposed environmental regulations, health/ecology impacts, state-of-the-art of associated control technologies, and environmental modeling. This information was analyzed and utilized in Task 6 to develop the goals and objectives of the expanded, unified CCEA program. Goals and objectives for standards, control technology develop-

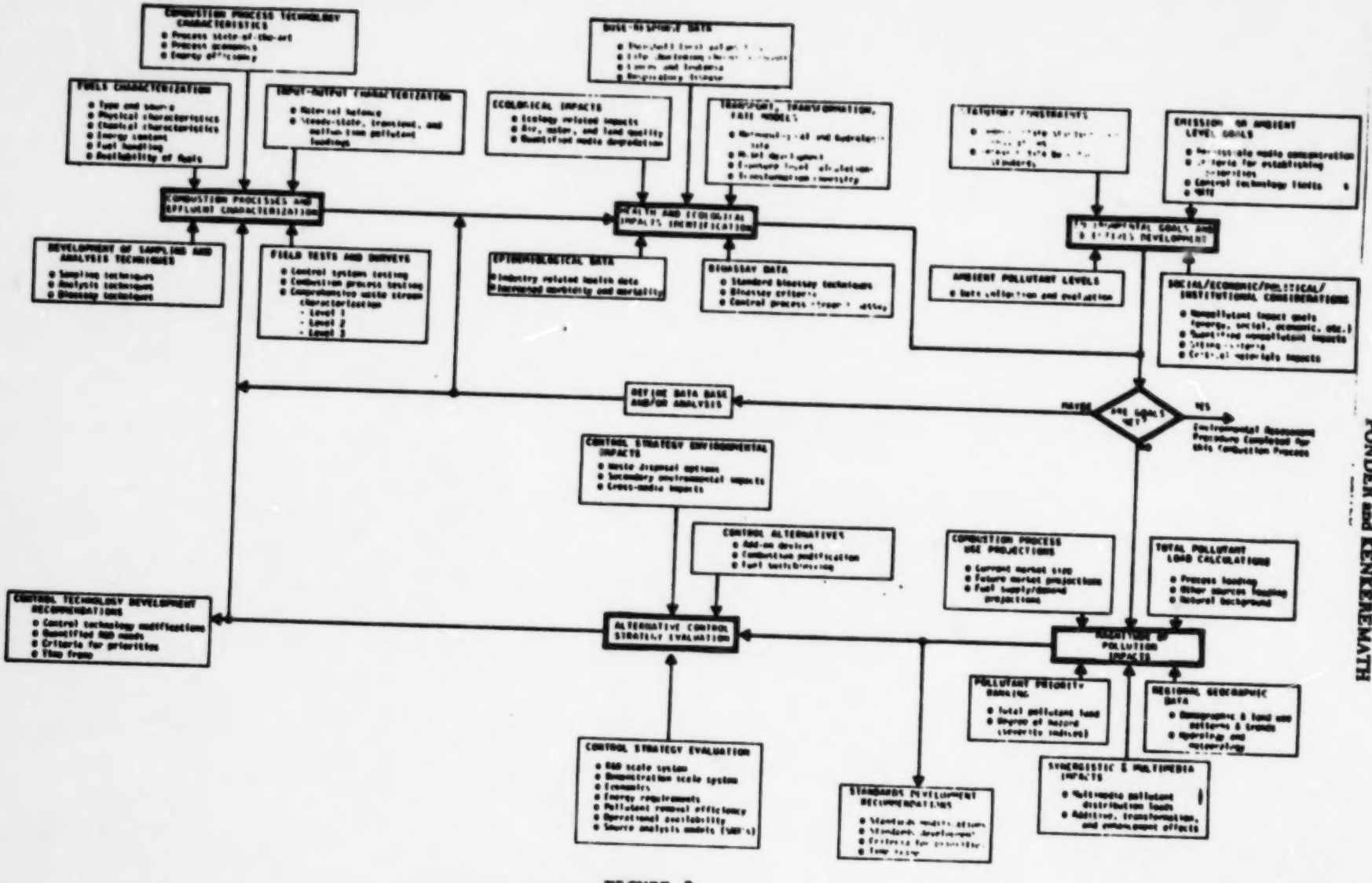

FIGURE 8

COMPREHENSIVE ENVIRONMENTAL ASSESSMENT METHODOLOGY

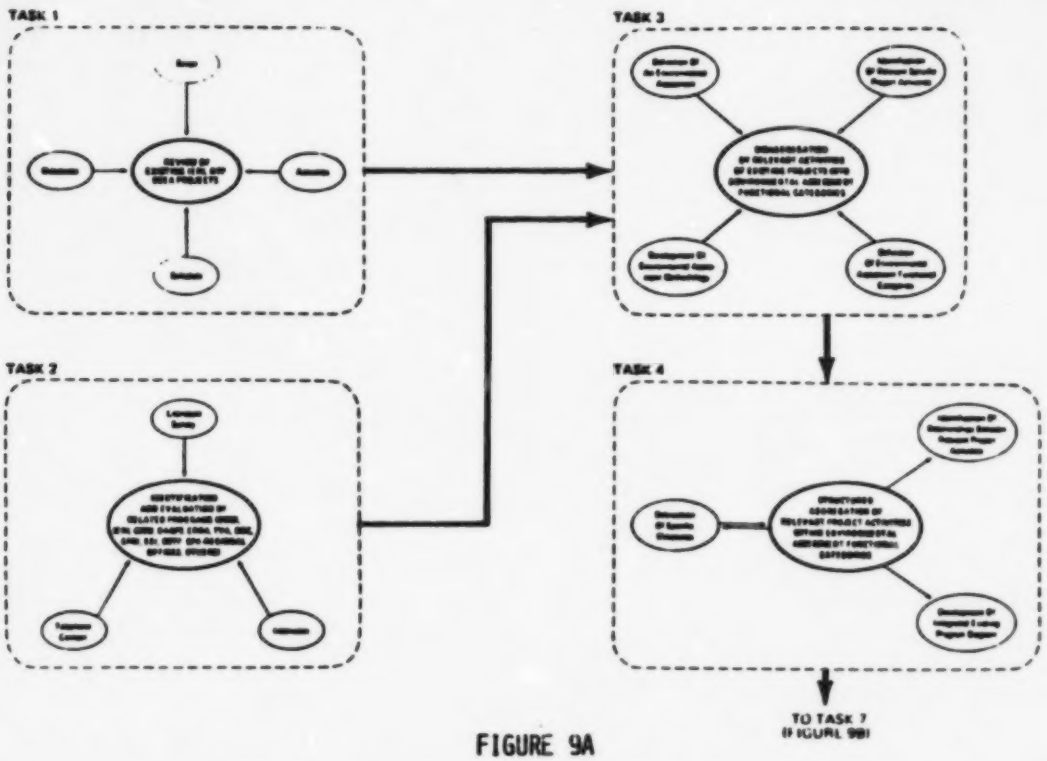

FIGURE 9A

UNIFIED CONVENTIONAL COMBUSTION ENVIRONMENTAL ASSESSMENT PROGRAM PLANNING

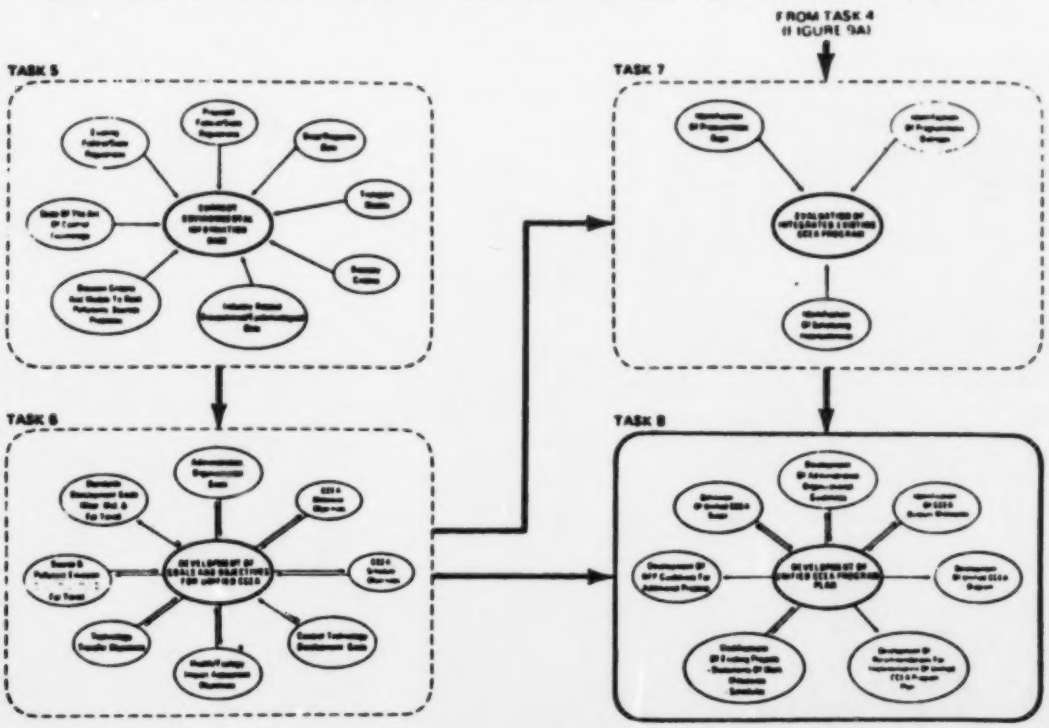

FIGURE 9B

UNIFIED CONVENTIONAL COMBUSTION ENVIRONMENTAL ASSESSMENT PROGRAM PLANNING

ment, and technology transfer were formulated. Administrative and organizational goals for the implementation of the unified CCEA program plan were also developed in Task 6.

The existing combustion assessment related activities, integrated into functional categories in Task 4, were evaluated in Task 7 with respect to the newly developed unified CCEA goals and objectives. By such a comparative evaluation, programmatic gaps within the existing structure could be identified. Programmatic overlaps among the various existing programs as well as possible incompatibilities in scheduling could also be identified within this Task.

The results of this comparative evaluation were matched in Task 8 with the goals and objectives for the CCEA in order to develop a coherent and integrated plan for the coordination and implementation of a unified CCEA program. This plan is designed to define the scope and elements of the unified CCEA, and identify specific outputs and milestones consistent with the CCEA goals and objectives. The plan also includes guidelines for implementing and administering the unified CCEA, recommendations for modifying various individual projects for consistency, and guidelines for the conduct of other initiatives as needed to fill selected gaps in current CCEA activities.

B. Program Plan Developmental Effort

The results of Tasks 1 and 2 yielded an impressive set of more than 500 ongoing and recently completed CCEA-related projects within EPA, other Government agencies, and nonprofit organizations. While analysis of this vast body of information is central to the process of establishing a comprehensive environmental assessment, the magnitude of such an undertaking is clearly beyond the scope of the current effort. Consequently, a manageable set of "core" projects is initially integrated into the unified CCEA to exemplify the methodology, and other efforts will be integrated as resources become available.

In order to reduce the number of CCEA-related projects for inclusion in the core set, several basic selection criteria were developed. Since the selection process was carried out on preliminary data, some judgment in the use of these criteria had to be exercised. Five of the major criteria used for the selection of core projects are outlined as follows:

1. Since the CCEA program can exercise greater influence over those programs funded by EPA, a greater weighting should be given to EPA projects in selecting the core CCEA projects. The CCEA program, in order to be able to conduct a unified and coordinated environmental assessment, should have the capability to guide or redirect ongoing and future R&D efforts.

2. All projects selected should be ongoing or proposed since no redirection could be provided to past efforts.

3. Projects chosen should address a wide spectrum of environmental assessment areas such as input/-output characterization and bioassay testing. Since the CCEA program planning is an effort to develop an overall coordinated structure, the core selection should reflect the diversity of information necessary for the comprehensive environmental assessment of conventional combustion processes.

4. Projects chosen should reflect the emphasis of current environmental assessment R&D efforts. Priority should be given to heavily funded projects since funding levels usually indicate priorities established by the funding agencies.

5. Projects chosen should have substantial information readily available. This criterion is utilized after the others have been applied in order to provide a manageable number of R&D efforts for the detailed analysis.

The application of criteria 1 through 4, above, yielded a set of 32 relevant projects from which the core CCEA projects were chosen. Table 3 shows the title, period of performance, sponsor, and EPA project officer for each of the 32 projects. Criterion 5 was then applied to the above set to select the

TABLE 3

POTENTIAL EPA-SPONSORED CCEA CORE PROJECTS

PERIOD OF PERFORMANCE	PROJECT OFFICER	TITLE
5/75-9/78	D. Kirchgessner	Trace Element Characterization and Removal/Recovery from Coal Wastes
2/76-3/80	J.W. Jones	Processing Sludges from Lime/ Limestone Wet Scrubbing
1/76-12/79	R.A. Venezia	Characterization of Effluents from Coal-Fired Utility Boilers
4/77-	J.W. Jones	Assessment of Effects of More Stringent NSPS for Power Plant SO_2 Emissions
12/75-4/78	W.S. Lanier	Advanced Combustion Systems for Stationary Turbine Engines
3/76-	J.W. Jones	LG&E Full-Scale Scrubber Testing and Waste Disposal Program
1/76-	R.E. Hall	Field Testing--Combustion Modifications of Industrial Combustion Equipment
12/75-4/78	W.S. Lanier	Advanced Combustion Systems for Stationary Gas Turbine Engines
3/76-	J.W. Jones	LG&E Full-Scale Scrubber Testing and Waste Disposal Program
3/76-3/79	L.D. Johnson	Sampling and Analysis Methods for POM and Other Organic Pollutants
2/77-10/79	J.S. Bowen	Environmental Assessment of Stationary Source NO_x Control Technologies

TABLE 3 (Continued)

PERIOD OF PERFORMANCE	PROJECT OFFICER	TITLE
1/77-8/78	G.B. Martin	Design Optimization, Construction and Field Optimization of Integrated Residential Furnace
9/76-	L.E. Sparks	Evaluation of Hot Side ESP's
9/76-10/78	J.D. Kilgroe	Combustion of Hydrothermally Treated Coal
9/76-1/80	N. Kaplan	Full Scale Utility Double Alkali Demonstration
3/77-1/80	R.A. Venezia	E/A of Conventional Combustion Systems
9/76-	C.J. Chatlynne	Advanced Regenerable FGD Demonstration
1/77-	--	Effects of Pathogenic and Toxic Materials Transported Via Cooling Device
3/77-12/78	W.H. Ponder	Comparative Multimedia Assessment: Well-Controlled Coal-Fired & Oil-Fired Boilers
3/77-7/79	J.H. Wasser	Evaluation of Emissions and Control Technology for Industrial Stoker Boilers
3/77-6/78	L.E. Sparks	Effects of Conditioning Agents on Emissions from Coal-Fired Boilers
3/77-12/79	J.H. Wasser	Environmental Assessment of Afterburner Combustion Systems
2/77-2/80	W.S. Lanier	Fundamental Combustion Research Applied to Pollution Control
3/77-7/78	J.W. Jones	Study of Disposal of By-Products from Non-Regenerable FGD Systems

TABLE 3 (Concluded)

PERIOD OF PERFORMANCE	PROJECT OFFICER	TITLE
6/77-6/81	N. Kaplan	Test Program for the Full Scale Double Alkali FGD Utility Demonstration
5/77-	G.L. Johnson	Fine Particle Emissions Information System Development
6/77-	D.G. Lachapelle	Evaluation of Pollutant Emissions from Industrial Burners Using "Dirty" Low and Medium BTU Gases
6/75-	J.W. Jones	Evaluation of Alternatives for Disposal of FGD Sludges
75-82	--	Advanced Particulate Control Pilot Plant (ARAPAHOE) & Technical Field Support
7/75-7/78	G.E. Glass	The Impact of Coal-Fired Power Plants on the Environment
74-5/78	R.E. Hall	The Effect of Combustion Modification on Pollutants and Equipment Performance of Power Generation Equipment
7/75-12/78	L. Smith	An Integrated Assessment of Electric Utility Energy Systems

core projects for integration into the unified CCEA.*

The disaggregation of these projects was performed with the aid of an information checklist outlining the major elements (activities) of the comprehensive environmental assessment methodology. The checklist was used in identifying which of the EA elements were addressed by each of the projects. Thus, comparison between projects of the disaggregated information could delineate all the efforts addressing a single EA element.

In order to perform such comparison between projects and to later facilitate their integration in the unified CCEA program, a code corresponding to the elements of the EA methodology was developed and applied to the information in the checklist (Table 4). The code specified whether the particular project merely identifies existing information on the EA element, develops or designs information on the EA element, or applies or performs the environmental assessment element.

In addition to the identification of environmental assessment elements addressed by each selected project, information regarding the specific pollution control technologies, pollutants, fuels, use sectors, and combustion processes/technologies involved is also necessary for comparative evaluation and future integration. Table 5 lists the codes utilized for use sectors, fuels, pollutants, and combustion processes/technologies; Table 6 shows the various categories of pollution control technologies.

The combination of the fuels (Table 5), use category (Table 5), pollution control technology (Table 6), media, environmental assessment element (Table 4), and pollutants (Table 5) describes completely all the areas included in a comprehensive environmental assessment of conventional combustion processes. It is the goal of the CCEA program planning effort to integrate ongoing projects and recommend new efforts to address all practical combinations of the above categories of information.

Figure 10 describes the relationships between each of the above categories. With the type of CCEA program matrix shown in Figure 10, R&D being conducted for any given fuel could be traced for each use sector, combustion technology/process, pollution control technology, media, environmental assessment element, and pollutant. Or, if one were interested in all the research being conducted by the CCEA program on a particular use sector, the CCEA matrix would facilitate a trace for any of the other parameters being addressed in terms of that use sector.

Figure 10 is a general diagram showing all possible combinations of factors considered in an EA. Figure 11 is an example which shows how all of the information from one of the core projects would be presented in the CCEA program matrix. This particular project is concerned with bituminous coal combustion in the utility sector. In particular, it addresses nine types of external combustion processes. Let us choose the research being conducted for combustion process SWDP--a Single-Wall Fired, Dry, Pulverized unit. The matrix shows that the project is concerned with the environmental impacts on air, water, and land media of (1) a flue gas scrubber attached to the SWDP unit and (2) the waste disposal practices associated with the operation of the scrubber. Figure 11 shows that 14 EA elements are addressed by this project. Let us examine the research involved in element E3---comprehensive Waste Stream Characterization. Level 2 analysis is being conducted for SO_x, trace elements, and ions. Thus, the figure shows that the research being conducted on bituminous coal-fired utility SWDP unit using scrubbers includes Level 2 analysis for SO_x in the air media. Repetition of the above process for other pollutants and EA elements would indicate all the information content of this project.

When information from all the core projects is coded in the CCEA program matrix, the integration process (Task 4, Figure 9A) is essentially complete. The comparison between projects addressing similar EA elements, control technologies, pollutants, use sectors, combustion process/technology, or fuel is relatively straightforward. This comparative evaluation identifies any potential overlaps that may exist between re-

*It is stressed here again that the limited set of projects selected for detailed evaluation is not intended as a complete representation of the wide range of research being pursued by the many agencies involved in environmental assessment activities. Rather, it presents the CCEA program planning methodology which will be used in integrating other projects as a manpower and funding permit.

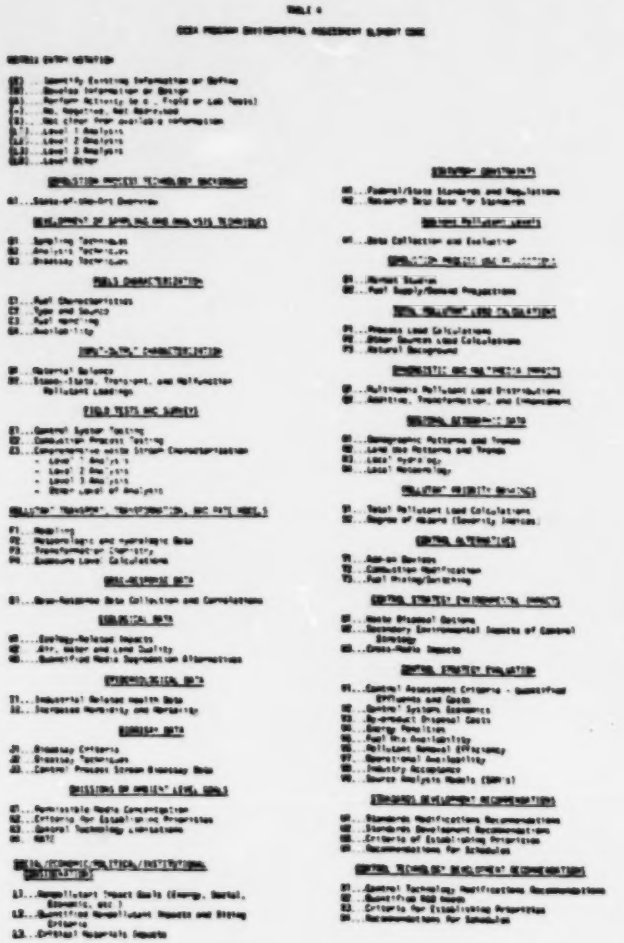

TABLE 5

USE SECTOR, FUELS, COMBUSTION PROCESS TYPE, COMBUSTION TECHNOLOGY, AND POLLUTANT CATEGORIES

USE SECTOR	U... Utility
	C... Commercial/Institutional
	R... Residential
	I... Industrial
FUELS .	RO... Residual Oil
	DO... Distillate Oil
	AC... Anthracite Coal
	BC... Bituminous Coal
	SBC... Sub-bituminous Coal
	LC... Lignite Coal
	SRC... Solvent Refined Coal
	R... Refuse
	NG... Natural Gas
	SNG... Synthetic Natural Gas
	A... Alcohol
	H... Hydrogen
	SO... Shale Oil
COMBUSTION TECHNOLOGY	IC... Internal Combustion
	EC... External Combustion
COMBUSTION PROCESS TYPE	TB... Turbine
	RE... Reciprocating Engines
	SW... Single Wall-Fired
	HO... Horizontal Opposed Wall-Fired
	T... Tangentially Fired
	SWDP... Single Wall-Fired, Dry, Pulverized
	SWWP... Single Wall-Fired, Wet, Pulverized
	HODP... Horizontally Opposed-Wall, Dry, Pulverized
	HOWP... Horizontally Opposed-Wall, Wet, Pulverized
	TDP... Tangential, Dry, Pulverized
	TWP... Tangential, Wet, Pulverized
	SK... Stokers
	V... Vertical
	C... Cyclone
	O... Other
	WT... Water Tube
	FT... Fire Tube
	CIB... Cast Iron Boiler
	S... Shell

POLLUTANTS		
	1. Particulates	8. Organics
	2. SO_x	9. Trace Elements
	3. NO_x	10. Ions
	4. POM	11. O_3
	5. CO	12. Thermal
	6. HC	13. Noise
	7. Inorganics	14. Other

TABLE 6

POLLUTION CONTROL TECHNOLOGY CATEGORIES

Pollution Control Technologies

- Uncontrolled
  - Air
  - Water
  - Land
  - Other
- Gas Treatment
  - Mechanical Collection
  - Electrostatic Precipitators
  - Filters (fabric, granular, etc.)
  - Liquid Scrubbers/Contactors (aqueous, inorganic, organic)
  - Condensers
  - Solid Sorbents (molecular sieves, activated carbon)
  - Incineration (direct, catalytic)
- Liquids Treatment
  - Settling, Sedimentation
  - Precipitation, Flocculation, Sedimentation
  - Centrifugation and Filtration
  - Evaporation and Concentration
  - Distillation, Flashing
  - Liquid/Liquid Extraction
  - Gas/Liquid Stripping
  - Neutralization
  - Biological Oxidation
  - Wet Thermal Oxidation
  - Activated Carbon Absorption
  - Ion Exchange System
  - Cooling Tower (wet & dry)
  - Chemical Reaction & Separation
- Solids Treatment
  - Fixation
  - Recovery/Utilization
  - Processing/Combustion
  - Chemical Reaction & Separation
  - Oxidation/Digestion
  - Physical Separation (specific gravity, magnetic, etc.)
- Final Disposal
  - Pond Lining
  - Deep Well Reinjection
  - Burial and Landfill
  - Sealed-Container Storage
  - Dilution
  - Dispersion
  - Ocean Disposal
- Process Modification
  - Feedstock Change/Fuel Treatment
  - Stream Recycle
- Combustion Modification
  - Flue Gas Recycle
  - Water Injection
  - Staged Combustion
  - Low Excess Air Firing
  - Optimum Burner/Furnace Design
  - Alternate Fuels/Processes
- Accidental Release Technology
  - Containment Storage
  - Spill Cleanup Techniques

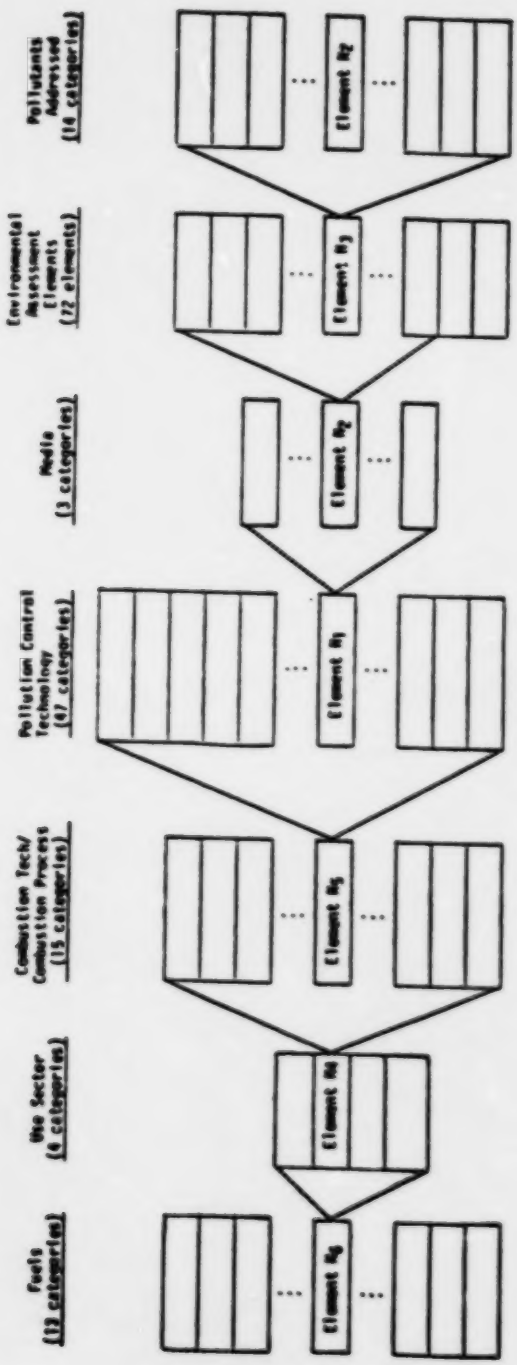

FIGURE 10

MATRIX OF ENVIRONMENTAL ASSESSMENT ELEMENTS

FIGURE 11

SAMPLE INFORMATION IN ENVIRONMENTAL ASSESSMENT MATRIX FORMAT

lated efforts. Comparison of this integrated matrix with the goals and objectives of the unified CCEA (Tasks 5 and 6) identifies potential R&D gaps that currently exist in the core CCEA. Reconciliation of the overlaps and new initiatives to fill gaps should complete the entire CCEA program matrix. This completed CCEA program matrix, then, would summarize the R&D to conduct a comprehensive environmental assessment of conventional combustion processes.

C. CCEA Program Planning Status

The CCEA program planning effort has been completed and the CCEA Program has been implemented. The identification and evaluation of related ongoing and proposed projects have resulted in the choice of approximately a dozen R&D projects that are integrated to form the core, unified CCEA program. Potential program gaps and overlaps have been identifed and recommendations for their resolution have been made.

A report describing results of the initial planning effort, including the unified CCEA program plan and recommendations for its implementation were submitted by MITRE/ Metrek to EPA/IERL-RTP's Utilities and Industrial Power Division in July 1978. EPA/IERL-RTP, with the assistance of contractors with experience and expertise in the various areas associated with the comprehensive environmental assessment of conventional combustion processes, has implemented the CCEA program. A comprehensive data base on conventional combustion processes and associated control technologies has been assembled and is currently being used to address high priority Agency issues such as 1) dioxin emissions, 2) POM emissions from wood combustion, 3) co-firing of fossil fuels emissions, and 4) trace metal emissions.

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